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ABSTRACT

This report addresses the variability among higher education institutions of percentages of undergraduate engineering enrollments represented by women. The report cites variations of from 20% of the full-time undergraduate engineering enrollment of women to the traditional 1% to 2% at different institutions. The report specifically addresses the issue of what can be done by an engineering college dean to facilitate the entry and retention of women in undergraduate engineering programs. Policy guidelines are provided. (Author/RE)

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FINAL REPORT

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THE RECRUITMENT AND RETENTION OF WOMEN IN ENGINEERING: DEVELOPMENT OF POLICY GUIDELINES

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By
Terry Connolly and Alan L. Porter

DECEMBER 1978

GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF INDUSTRIAL & SYSTEMS ENGINEERING
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Georgia Institute of Technology

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EXECUTIVE SUMMARY

Engineering has traditionally been almost entirely a male profession. As recently as 1970, only about 1% of undergraduate engineering degrees awarded in this country went to women. In recent years, however, the situation has been changing very rapidly. As of Fall, 1977, women represented 10% of the full-time undergraduate engineering students, and a still larger fraction of the entering class. This rapid growth, while geographically very widespread, has been highly variable between schools. Several schools have seen their female enrollments grow to 20% or more of their full-time undergraduate student body, while others remained at the traditional 1-2% women. The present study explores the causes of this variability between schools in their enrollments of women students. Specifically, it addresses the question: What can be done by an engineering college dean to facilitate the entry and retention of women in undergraduate engineering programs?

The Policy Recommendations offered (Attachment I) are based on a number of project activities. The study drew on a body of previous research (by ourselves and others), and was under the general guidance of an Advisory Panel, comprising both researchers and practitioners in the area. Three

main research activities were undertaken: (a) an analysis of enrollment changes at all U.S. engineering schools between 1972 and 1976, drawing on published sources; (b) a focussed study of the women-oriented activities at sixty schools, representing the thirty most-successful and thirty least-successful schools in attracting women, with data generated by a combination of questionnaire and telephone interviews; and (c) an in-depth study of one rather successful program, drawing on questionnaires completed by entering men and women students before and after their first year of study, and on interviews with school officials involved with women-oriented programs.

The major conclusion to emerge from these analyses is that the design of an effective women-oriented program is a complex problem. There is no single key to its solution, nor is there a single approach effective for every school and setting. Rather, the success of such programs appears to be determined by the extent to which they address two underlying mechanisms, offered here as hypotheses:

1. The Decision-Support Hypothesis: Engineering is a high-uncertainty choice of major for a woman student, with implications and consequences hard for her to assess. Thus at each of the major decision points from high-school through professional practice, a woman needs more decision support than does a man if the choice of engineering is to remain a realistic option.

2. The Positive Feedback Hypothesis: For several reasons, schools which currently have large enrollments of women face fewer difficulties in subsequent recruiting than do those recruiting substantial numbers of women for the first time. Successful programs thus tend to be self-reinforcing, while unsuccessful programs tend to face persistent problems.

In designing an effective program aimed at women, then, the administrator must first assess the school's current performance. If current enrollment is less than 10% women in the entering class, the school is substantially

lagging national trends in this regard, and may wish to mount an intensive, focussed effort to 'break in' on the positive feedback loop. Women enrollments in excess of 15-20% would suggest more of a 'growth maintenance' strategy, in which sustained but less intensive effort should maintain the school's gains in this area. Detailed recommendations for strategies of both kinds are offered in Attachment I of this Report.

Attachment I has been mailed to every engineering college in the U.S., supplementing the normal dissemination of research results through the scholarly literature. The long-run impact of the study is, of course, dependent on the extent to which these proposals are implemented by college administrators. We hope to be able to monitor such implementation and the impact on enrollments of women engineering students over the next several years. The demonstration of such an impact would, we believe, be of considerable value not only in the field of engineering education, but also as a source of insight and effective intervention in a variety of other 'non-traditional' career areas for women.

In addition to the Policy Guidelines offered in Attachment I, a more detailed overview of the research results is attached (Attachment II). Further focussed analyses of specific parts of the data are in progress; reports of these may be obtained from the authors.

I: PROJECT DESCRIPTION.

a: Background: During the early and middle 1970s, the numbers of women students entering undergraduate engineering programs in the U.S. underwent a dramatic and continuing increase. As recently as 1970, women represented only about 1% of all recipients of undergraduate engineering degrees, a figure which had remained unchanged for many years. By Fall of 1977, women represented fully 10% of the full-time undergraduate engineering students in this country, and over 11% of the entering class. Undergraduate engineering education (and by implication the engineering profession) thus represents the only professional area we know of in which the representation of women has increased by an order of magnitude during this time frame. The phenomenon is of considerable interest, both of itself and in terms of the insight it might provide for other 'non-traditional' career areas for women.

The focus of the present study was on the role of the individual engineering schools in stimulating this growth. Specifically, a preliminary analysis of enrollment trends showed that the growth in percentage of women was geographically widespread, but was extremely variable from school to school. As of 1976, the ten schools most successful at attracting women were approaching 20% women in their full-time undergraduate student body; the ten least successful schools (excluding military academies) remained below 2%. Our assumption was that at least part of this variation between schools was the result of differences in their recruiting strategies and other women-oriented activities. The aim of this study, then, was to identify specific activities and strategies which, if implemented by a given school, showed promise of increasing the entry and retention of women students in undergraduate engineering programs.

b. Study Design: As originally proposed, the study was to include three major elements: (i) an analysis of enrollment trends between 1972 and 1976 for all

U.S. engineering schools, using published data; (ii) a focused study of the 50 schools most successful in attracting women (as reflected in their 1976 enrollments), with data gathered both from published sources and from telephone interviews with administrators at each school; and (iii) an in-depth study of one rather successful program, that at Georgia tech, drawing on questionnaire data from both men and women, at entry and at the completion of the first year of study, and on interviews and documents from staff and faculty involved with women-oriented programs. In addition to these data-gathering efforts, the design included a survey of existing literature, and the establishment of an Advisory Committee of six administrators and researchers who would help guide the study and review its outcomes.

Two significant changes were made in this design as the study developed. First, the sample design in part (ii), the focussed study, was changed from the 50 most-successful schools to a contrast sample of the 30 most-successful and 30 least-successful schools, further stratified by school size (into small, medium, and large engineering programs). This modification improved both the analytic clarity of the results (by allowing direct comparison of successful and unsuccessful programs) and the generalizability of the findings (by allowing statistical control for school size). A second change from the proposed design was the addition of data from a survey published by the American Society for Engineering Education of women-oriented activities at over 100 engineering schools. We were unaware of the existence of this survey at the outset of the study, and found it a useful if imperfect addition to our available data. With these exceptions, the study was conducted essentially as originally proposed.

While the study as conducted was quite close to that initially proposed, our initial assessments of the quality and availability of various types of

data were often substantially in error. In general, we underestimated the time and effort involved in collecting several types of data, and overestimated its likely quality. The most serious slippage occured in the telephone interviews with engineering college administrators, from which we hoped to gather data both on enrollment patterns and changes at each school, and specific detail of the women-oriented activities at each. A total of 4 person-weeks of professional effort was budgeted for the development and mailing of the relevant questionnaires, and for the conduct of the telephone interviews. In the event, this estimate was low, perhaps by an order of magnitude: this phase of the work extended over six calendar months, and involved at least part-time work from five individuals. The telephone interviews, in particular, turned out to be a most difficult means of collecting reliable information. College administrators were often difficult to contact (requiring, in one case, 14 different long-distance calls). We were frequently referred to officials less well-informed than we hoped. Several of the classes of data we sought (for example, drop-out rates for men and women) were simply not available in most cases. And some of our respondents, particularly those at less-successful schools, were evasive and non-specific when pressed on the details of their women-oriented activities. In short, the combination of questionnaires and structured telephone interviews which we planned for part (ii) of the study turned out to be considerably more costly of time and effort, and somewhat less productive in terms of resulting data breadth and quality, than we had initially expected. In retrospect, a larger fraction of the study budget should have been allocated to this part of the work, and less yield of high-quality data expected. (On the other hand, the approach still appears more cost-effective than the alternative of a series of on-site interviews, with the considerable travel costs this would require.)

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In summary, the study design originally proposed was found to be basically a serviceable one and, with the two additions noted above, guided the study well. In retrospect, however, we would have to conclude that our original budget estimates were too low. Even with an extension of one calendar month, and an additional $6,000 of additional funding provided by FIPSE, over the original plan, the study would not have been brought to completion without a considerably input of unrecompensed effort from the research team.

II: PROJECT RESULTS.

The primary output from this study is the document included as Attachment I to this Report, entitled: "Women in Engineering: Policy Recommendations for Recruitment and Retention in Undergraduate Programs". This document, which has been mailed to all engineering schools in the U.S , gives a brief overview of the current status of women in engineering programs, a summary of the present study and, most importantly, a set of policy recommendations providing specific suggestions as to what should be done by an engineering college dean wishing to increase the enrollment of women in his or her undergraduate program. It is our belief that this document, in its brevity, action-orientation, empirical support, and direct accessibility to engineering-school deans, offers the best prospect for a direct impact from this study on the development of effective women-oriented programs in engineering colleges, and thus on the numbers of women engineering students.

In addition to this direct-mail approach to dissemination we are, of course, following the normal channels of scholarly publication. One paper, a report of the major findings from the study, is included here as Attachment II. (It is presently under review for publication in Engineering Education.) We are preparing a paper on the first-year socialization experiences of the woman engineering undergraduate. A preliminary version will be presented at the annual conference of the American Society for Engineering Education in June 1979, with a later version to be published. We are thus moving to bring the results and implications of the study both directly to the attention of relevant users (engineering college deans) and to the wider research community.

We will not attempt to summarize the detailed findings and implications of the study here, since they are reported in the two Attachments to this Report. We would, however, like to offer one general conclusion. It is that the rapid entry of women into undergraduate engineering education in recent

years is a complex social phenomenon; and that, as a result of this complexity, the discretionary role of engineering schools in facilitating such entry is smaller than we initially expected. The original proposal conveys a sense of hubris, an implication that the study would uncover a small number of key activities which, if implemented, would make a decisive impact on woman enrollments at any given school. The data, in contrast, argue for rather more humility. Certainly, we would expect that careful and persistent attention to the concerns summarized in Attachment I should achieve a substantial long-run impact. We do not, however, expect such achievement to come immediately from implementation of a few low-cost, low-effort standard tricks. Rather, we see a high-impact women-oriented program as requiring substantial, ongoing effort on the part of the school, addressing a wide range of interconnected issues, and tailored by continuing experimentation to the needs and opportunities of each individual school. Obviously, we believe the effort is justified. But we do not believe that instant success will be achieved by merely introducing one or two magical devices.

III: ACHIEVEMENTS AND SHORTCOMINGS.

The ultimate aim of the present study is to facilitate entry into, and retention in, engineering programs for women. Obviously, we cannot at this point assess our success in achieving this long-term goal. We can, however, specify the process which is required in reaching the goal, and assess the achievement of those steps which are completed thus far.

a. Research adequacy: The first requirement is that the research elements of the study be competently conducted. This includes the research design and data collection, analysis, and drawing of appropriate inferences. Our assessment here is positive: we believe the study was conducted to good professional standards, an assessment reflected in the concurrence of our Advisory Committee and (we hope) in the judgement of professional colleagues reviewing the research papers flowing from the study. While no empirical study is perfect, we believe this one to be of a competent and careful professional standard.

b. Supportable recommendations: The second necessary process step is that the research understanding gained be translated into action recommendations with demonstrable potential impact. Again, our assessment here is positive. We believe that the recommendations offered in Attachment I are firmly based in the research findings. Further, they are in tune with the practical experience of the members of our Advisory Committee who have been involved in women-oriented activities for women engineering students.

c. Adequate dissemination: The third necessary step is that the recommendations be brought to the attention of the relevant user audience. We believe that the dissemination plan of direct mailing to engineering college deans plus normal publication channels should serve this requirement adequately.

d. Acceptance and adoption: We have at present no data bearing on the extent to which the user audience of engineering deans finds the recommendations acceptable, or intends to adopt them. A brief questionnaire addressing these questions was included in the national mailing of Attachment I, as was an order form for the full study report (Attachment II). Questionnaire responses and requests for the full report will provide some indication of the user audience's response. Other indications will be the number of inquiries received in response to this mailing, requests for article reprints, citations of our papers in subsequent research, and so on. These data are not presently available.

e. Evidence of impact: The final and most critical element in assessing the success of this study will be the 'hard numbers' -- evidence that at least some of the potential user audience actually implemented at least some of our recommendations, and that their enrollments of women subsequently increased. Needless to say, evidence of such impact is not yet available.

In short, to the extent to which we are now able to assess this work, we judge it to be a success. While far from perfect, the empirical research is solid, it has been successfully translated into supportable action recommendations acceptable to professional peers, and the recommendations have been widely disseminated to the potential user audience. Unfortunately, this assessment must stop short of the two critical questions: will the recommendations be accepted and adopted by the potential users? and will they bring about positive impact if they are implemented? Evidence bearing on either of these questions will, inevitably, be some time in coming.